Published in final edited form as:
J Dev Behav Pediatr. 2007 December ; 28(6): 438–447. doi:10.1097/DBP.0b013e31811ff8ca.

Relationship Between Speech-Sound Disorders and Early Literacy Skills in Preschool-Age Children: Impact of Comorbid Language Impairment

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Abstract

Objective: Disorders of articulation or speech-sound disorders (SSD) are common in early childhood. Children with these disorders may be at risk for reading difficulties because they may have poor auditory, phonologic, and verbal memory skills.

Methods: We sought to characterize the reading and writing readiness of preschool children with SSD and identify factors associated with preliteracy skills. Subjects were 125 children aged 3 to 6 years with moderate to severe SSD; 53% had comorbid language impairment (LI). Reading readiness was measured with the Test of Early Reading Ability-2 (TERA) and writing skills with the Test of Early Written Language-2 (TEWL), which assessed print concept knowledge. Linear regression was used to examine the association between SSD severity and TERA and TEWL scores and analysis of variance to examine the effect of comorbid LI. Performance on a battery of speech and language tests was reduced by way of factor analysis to composites for articulation, narrative, grammar, and word knowledge skills.

Results: Early reading and writing scores were significantly lower for children with comorbid LI but were not related to SSD severity once language status was taken into account. Composites for grammar and word knowledge were related to performance on the TERA and TEWL, even after adjusting for Performance IQ. Below average language skills in preschool place a child at risk for deficits in preliteracy skills, which may have implications for the later development of reading disability.

Conclusion: Preschool children with SSD and LI may benefit from instruction in preliteracy skills in addition to language therapy.

Keywords

speech-sound disorders; language impairment; preschool literacy skills; print concept knowledge

Speech and language disorders are among the most common developmental conditions in early childhood, affecting 4% to 10% of children.[1,2] Some studies report rates of expressive language delay as high as 17.5% in preschool children.[3] Speech-sound disorders (SSD) involve impairments in speech-sound production and range from mild articulation issues involving a limited number of speech sounds to more severe phonologic disorders involving multiple errors in speech-sound production and reduced intelligibility. The prevalence of SSDs is highest for

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preschool-age children, and the condition appears to resolve in 75% of children by age 6.[4] In contrast, language disorders involve delays or deficits in expressive or receptive language development, or both, with an estimated prevalence of 7% at kindergarten age.[1] The goal of this study was to determine how preschool-age children with moderate to severe SSD perform on measures of early reading and writing. We sought to determine factors associated with early literacy skills among children with SSD, including co-existing language impairment (LI).

There has been significant emphasis on the role of phonologic processing, the ability to deconstruct spoken and written language into phonemes, and reading decoding skills in the development of later reading skills.[5-7] A strong relationship has also been found between LI in early childhood and reading comprehension difficulties at school age.[8-12] There is significant overlap between LI and reading impairment in groups of children identified as having either disorder,[13,14] and reading disability is viewed as a form of LI by some authors.[15]

In addition to increasing the risk for reading problems, LI is related to difficulties in a number of other areas. Preschoolers with language disorders have been found to have weaker development of print concept knowledge than controls.[16,17] Furthermore, delays in language development can have significant negative effects on a young child's social and emotional functioning, including an increased risk for social problems, anxiety, depression, and attention problems.[3,18,19]

In contrast with the association between LI and reading disability, studies of the relation between SSD in early childhood and reading disability at school age have shown mixed results.[9,20-23] Children with SSD and comorbid LI are at significantly increased risk for reading disabilities at school age compared with controls.[21,22] Those with isolated SSD, however, do not appear to be at higher risk for reading disabilities, although they are at risk for spelling difficulties, particularly if the speech disorder persists after age 6.[21-23]

A number of risk factors, including male sex and lower socioeconomic status (SES), are known to increase the risk for speech and language disorders and problems with literacy. Boys appear to be at somewhat increased risk for speech and language disorders compared with girls, with ratios as high as 2:1 in clinical samples,[4] although population-based studies report a more even distribution.[1,2] Parental language input to children of lower SES is often less frequent than the input to children from middle class families, and verbal interaction with children in lower SES homes is more likely to take the form of directives.[24,25] Lower SES is associated with poorer phonemic awareness and consequently poorer reading skills in childhood compared with middle class status.[26,27] In general, children from lower SES homes participate in fewer literacy-related activities, experience less adult modeling of reading,[28,29] and have decreased access to printed materials.[30]

In addition to phonologic processing, print concept knowledge, the rule-governed system of orthography and written language, is an important preliteracy skill that influences how rapidly and well children acquire literacy.[17] Print concept knowledge includes understanding print conventions such as left-to-right directionality and alphabet knowledge. The best predictors of children's early reading success include measures of both phonologic awareness and print concept knowledge.[31,32] Children with LI are more likely to show a delay in the understanding of the significance of print.[16] A longitudinal population-based study of kindergarten children found that five factors at kindergarten age predicted reading outcome in second grade: letter identification, sentence imitation, phonologic awareness, rapid naming, and the mother's educational attainment.[33]

Little is known about the early reading and especially early writing skills of preschool-age children with SSD. We sought to characterize these skills, print concept knowledge in particular, in the current study. Given that prior studies find that children with isolated SSD

may not be at significantly increased risk for later reading problems,[21,22] we hypothesized that there would be no association between the severity of a child's SSD and scores on measures of early reading and writing readiness (hypothesis 1). However, we anticipated that children with SSD who had comorbid LI would perform more poorly on measures of reading and writing readiness, as well as on measures of speech and language skills, than those without LI (hypothesis 2). This expectation was based on evidence for associations of LI with reading disability in school-age children[8-11] and with reduced print concept knowledge at preschool age.[16] We further hypothesized that performance on composite measures of language and phonologic processing skills,[34,35] but not speech skills, would be associated with early reading and writing readiness (hypothesis 3).

Although studies exist of children at kindergarten age, to our knowledge, there are no prior analyses of early reading readiness or early writing skills in children with SSD before kindergarten entry. Furthermore, among studies examining reading skills among children with LI, most do not distinguish between children with LI and those with comorbid SSD. This knowledge can help clinicians and speech therapists working with young children with speech and language disorders anticipate the academic needs of affected children and provide a rationale for early direct instruction in preliteracy skills.

METHODS

Participants

Participants were 125 children, 3 to 6 years of age, diagnosed with a moderate to severe speech-sound disorder (SSD). Participants were recruited from the clinical practices of speech and language pathologists at community speech and hearing centers or in private practice in the greater Cleveland area. They were part of an ongoing study of the genetics of SSD[36,37] and were tested between 1995 and 2004.

SSD include both errors of articulation or phonetic structure (errors caused by poor motor abilities associated with the production of speech sounds) and phonologic errors (errors in applying linguistic rules to combine sounds to form words). Participants with a moderate to severe SSD, defined as follows, were included in the study: (1) speech criteria: (a) a score at or below the 10th percentile on the Goldman-Fristoe Test of Articulation (GFTA) (Sounds in Words subtest)[38] and (b) three or more types of phonologic processing errors identified by the Khan-Lewis Phonological Analysis (KLPA) (mean percentile rank on the KLPA among study participants was 19.7, SD 24.0; these percentiles correspond to a moderate [21st–40th percentile] to excessive [1st–20th percentile] degree of speech simplification);[39] (2) normal hearing acuity, defined by passing a pure tone audiometric screening at 25 dB for 500, 1000, 2000, and 4000 Hz bilaterally and fewer than six parent-reported episodes of otitis media before age 3; and (3) normal oral-motor structure documented on the Oral and Speech Motor Control Protocol.[40] Only families who spoke Standard American English as their first language were included.

To focus the analysis on children with isolated speech and language problems, children with a history of neurologic disorders or developmental delays other than speech and language reported by the parent were excluded from the study. Children with a Performance IQ (PIQ) score below 80 on the Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R)[41] were also excluded. Siblings of children referred for the study were tested and included as study participants if they met all the above age, speech, and IQ criteria. In all, 125 children with SSD participated in the study, which included 108 probands and 17 similarly affected siblings.

Language impairment (LI) was defined as a score 1.5 SD below the mean on a structured language test (see definition under analysis). Sixty-six (53%) children were classified as having SSD with co-existing LI, and 59 (47%) had an isolated SSD without LI. All participants were assessed with the Test of Early Reading Ability-2 (TERA),[42] a measure of early reading readiness, and the Test of Early Written Language-2 (TEWL)[43]; both measures focus on print concept knowledge.

Demographic characteristics of the sample are presented in Table 1. The family's socioeconomic status (SES) was determined using the Hollingshead Four Factor Index of Social Class.[44] The sample was in majority male (64%), white (87%), and mainly of middle to higher SES. The two comparison groups, children with isolated SSD or with comorbid LI, were similar in their demographic characteristics. Testing results from 68 unaffected siblings, who were not included among the 125 study participants with SSD, were used as a normative sample for the study measures.

Procedures

Children were tested individually in their homes over two sessions to reduce the effect of fatigue on test results. Speech production measures were audiotape recorded using professional-quality equipment (Sony Professional Walkman, model WM-D6C, with an Audio Technica omnidirectional microphone, model AT804) and later phonetically transcribed. The Human Subjects Committee of University Hospitals of Cleveland approved the conduct of this study.

Speech and Language Measures—Speech-sound production skills were assessed using the GFTA Sounds in Words subtest, which measures articulation of single words elicited through pictures. All phonemes in the initial, medial, and final position of words as well as consonant blends were assessed.[38] Responses were audiotaped and transcribed for review. A conversational speech sample of 50 to 100 utterances was obtained to determine articulation in a spontaneous speech sample, scored using Percent Consonants Correct–Revised (PCC-R) criteria.[45] Phonologic production was assessed with the Multisyllabic Word Repetition Task[46] and the Speech Error Phrases Test.[46] Participants were asked to repeat 20 challenging words and 15 short phrases presented by audiotape. Responses were audio-taped, phonetically transcribed, and analyzed for phonologic processes and syllable structure.

Lexical and grammatical skills were assessed using a number of measures: (1) comparable subtests of the Test of Language Development (TOLD-P2)[47] or the Clinical Evaluation of Language Fundamentals–Preschool (CELF-P)[48] related to sentence recall and imitation and knowledge of word structure (the choice of measure depended on the child's age and year of study enrollment); (2) the Test for Examining Expressive Morphology (TEEM);[49] 3) the Peabody Picture Vocabulary Test–Revised (PPVT-R), a measure of receptive vocabulary;[50] (4) the Expressive One Word Picture Vocabulary Test–Revised (EOWPVT-R), a measure of expressive vocabulary;[51] and (5) a narrative task entitled “The Fox and the Bear Story,” which required the child to retell and answer questions about a story.[52]

Phonologic Processing Measures—Phonologic processing was assessed using (1) a Segmentation Task, which measures phonologic awareness;[10] (2) a Rapid Auditory Naming Task (rapid naming of colors only);[53] and (3) the Nonsense Word Repetition Test,[10] in which participants were asked to repeat 15 nonsense multisyllabic words presented by audiotape. These measures have adequate validity and have been used in prior studies by our group.[21,23,36,37,54]

Nonverbal IQ—To assess nonverbal intelligence, PIQ was measured using the WPPSI-R.[41]

Outcome Measures—The Test of Early Reading Ability-2 (TERA) was used to measure pre-academic reading readiness.[42] The TERA measures the ability to construct meaning from printed symbols, knowledge of the alphabet, and understanding of the conventions of written language (print concept knowledge) in children ages 3 to 9 years. The normative sample consisted of 1454 children residing in 15 states in the United States. The TERA has adequate test-retest reliability with alternate forms and adequate validity (content, criterion-related, and construct validity).

The Test of Early Written Language-2 (TEWL) was used to measure pre-academic writing readiness.[43] The TEWL measures basic writing ability, focusing on the functional components of writing, and contextual writing ability, focusing on story construction and structure, in children ages 3 to 11 years.[43] The normative sample for the TEWL consisted of 1479 children from 41 U.S. states and British Columbia. The TEWL has adequate test-retest and inter-rater reliability and adequate validity (content, criterion-related, and construct validity).

Design and Analysis

This study used a cross-sectional, correlational design. Statistical correction for multiple comparisons was not made because of the exploratory nature of the study. A significance level of $p < .05$ was used. Diagnosis of LI was based on scaled scores 7 or less on two subtests of the TOLD-P2 or CELF-P (scores > 1.5 SD below the mean) and parent report that the child was receiving therapy for a language problem, as previously defined by Tomblin et al.[1] and used in prior studies by our group.[21]

Principle axis factor analysis with direct oblique rotation was conducted to reduce performance on the battery of speech, language, and phonologic processing measures to composite factors (Table 2). Age-standardized z scores from 90 of the 125 participants with complete data on all measures were used to define the factors. Z scores were determined from the scores of 68 comparably-aged siblings tested in the study who had neither SSD nor LI (unaffected siblings) and a PIQ of 80 or more for all measures of articulation, phonologic production, and lexical and grammatical skills. Z scores were based on 29 to 68 observations, depending on the measure. To reduce the effect of outliers, the method of Winor[55] was used to truncate z scores less than −3 to a minimum value of −3 and z scores greater than 3 to a maximum value of 3. Residuals were examined and determined to be normally distributed for all measures so that transformation was not required.

Factor analysis yielded four groups of speech and language skills (Table 2): (1) an articulation factor, which included two articulation measures and two measures of phonologic production; (2) a narrative factor that included three components of the Narrative Task (includes 3 components: content items, factual questions, and inferential questions); (3) a grammar factor, which included grammatical completion, sentence imitation, and expressive morphology (TEEM); and (4) a word knowledge factor, which included expressive and receptive vocabulary and the Segmentation Task. PIQ and the three measures of phonologic processing (Segmentation task, Rapid Auditory Naming task, and Nonsense Word Repetition Test) were included in the factor analysis. However, only Segmentation loaded onto one of the speech/language factors (word knowledge).

To examine the association between SSD severity (z score on the GFTA) and standardized scores on the TERA and TEWL, linear regression was used, adjusting for the child's SES and sex (hypothesis 1). To examine the relation between comorbid LI and scores on the TERA and TEWL, analysis of variance was used, adjusting for SES and sex (hypothesis 2). Effect size was calculated using Cohen's d with pooled SD. Because the group with comorbid LI had more severe SSD than the group with SSD only, analysis of the associations of LI and SSD severity with the TERA and TEWL were also examined with the other variable entered as a covariate.

Hierarchic linear regression was conducted to examine the relation between performance on composite measures of speech and language skills and performance on the TERA and TEWL, adjusting for demographic factors (child's sex and family's SES) and PIQ (hypothesis 3). Variables were added to the model hierarchically; demographic factors were added first to examine the effect of the variables of interest after taking into account the effect of social background. Speech and language factors (grammar, word knowledge, narrative, and articulation) were then added as a block. The Rapid Auditory Naming Task and the Nonsense Word Repetition Task were added to the model to determine whether phonologic processing predicted performance on the TERA or TEWL above and beyond the speech and language composites. Last, PIQ was added to the model to determine whether it accounted for additional variance beyond the factors of interest. To provide descriptive data on the relation between individual measures, partial correlations were obtained between the speech and language factor scores, phonologic processing measures, PIQ, and TERA and TEWL scores, adjusting for the child's sex and SES.

RESULTS

Mean scores on the Test of Early Reading Ability-2 (TERA) and Test of Early Written Language-2 (TEWL), composite speech and language factors, phonologic processing measures, and Performance IQ (PIQ) for the two groups (speech-sound disorders [SSD] only and SSD with comorbid language impairment [LI]) are presented in Table 3. Mean scores are presented without adjustment, but F test statistics and *p* values are adjusted for differences in socioeconomic status (SES) and sex between groups. There was no association between the child's sex and presence of comorbid LI: 59% of boys and 42% of girls had LI (Pearson χ^2, $p = .076$). The mean PIQ of children with isolated SSD was approximately 10 points higher than that of children having SSD with comorbid LI ($p < .001$).

Related at least in part to the manner in which LI was defined, the groups differed significantly on nearly all speech and language measures, with lower scores for the SSD with LI group. Group differences ranged from 0.55 (articulation factor) to 1.57 (grammar factor) SD (Table 3). Group differences were not significant on the Speech Error Phrases Test and the Rapid Auditory Naming Task (data presented for phonologic processing measures only).

Hypothesis 1: Association Between Severity of Speech-Sound Disorder and Early Reading/Writing Readiness

Contrary with our hypothesis, when adjusting for the child's sex and SES, the severity of SSD was positively associated with the TERA ($p < .05$) but not the TEWL ($p = .15$). However, this association was no longer significant when controlling for group (i.e., for the effect of comorbid LI; see hypothesis 2 results).

Hypothesis 2: Associations of Language Impairment with Reading/Writing Readiness Skills

When adjusting for the child's sex and SES, LI was negatively associated with lower scores on both the TERA ($p < .01$) and TEWL ($p < .001$) (Table 3). The corresponding effect size (Cohen's d) was moderate for the TERA and large for the TEWL. Lower SES was also associated with lower scores on the TERA ($p < .05$), whereas sex was not associated with either of the literacy measures in univariate analyses.

Although severity of SSD predicted TERA scores, this association was not significant when the presence of comorbid LI was taken into account in the analysis ($p = .14$), raising the possibility that LI status, rather than SSD severity, accounted for the association. The child's LI status was a potential confounder because SSD was more severe in the group with comorbid LI.

Hypothesis 3: Association of Speech/Language Composites and Phonologic Processing with Reading/Writing Readiness

Linear regression modeling of the relationship between the speech/language composites and early reading readiness found that grammar skills and word knowledge predicted performance on the TERA ($p < .01$ and $p < .05$, respectively) after controlling for SES (Table 4). Articulation and narrative skills (factors) were not associated with TERA scores in the model. Although PIQ was also related to the TERA ($p < .05$), the relationship with the grammar factor remained significant when PIQ was included ($p < .05$) but was no longer significant for the word knowledge factor ($p = .06$). Phonologic processing measures (Rapid Auditory Naming and Nonsense Word Repetition Tasks) were not significant additional predictors of TERA scores.

There was a similar positive relationship between grammar and word knowledge factors and performance on the TEWL ($p < .01$ for both) after adjusting for the child's SES and sex (Table 4). Although PIQ was associated with the TEWL ($p < .01$), the relationship with grammar and word knowledge factors remained significant when PIQ was added to the model ($p < .01$ and $p < .05$, respectively). Phonologic processing measures (Rapid Auditory Naming and Nonsense Word Repetition Tasks) were not significant additional predictors of TEWL scores.

The final model for performance on the TERA included SES, language factors (grammar skills and word knowledge), and PIQ. Higher SES predicted higher TERA scores. These variables accounted for 32.4% of the overall variance in TERA scores (R^2). The final model for performance on the TEWL included SES, sex, language factors (grammar skills and word knowledge), and PIQ. Higher SES and female sex predicted higher TEWL scores. These variables accounted for 44.7% of the overall variance in TEWL scores (R^2).

After adjusting for SES and the child's sex, there was a significant, albeit small, partial correlation between the z score on the Segmentation Task and performance on the TERA and the TEWL ($p < .01$ and $p < .05$, respectively) (Table 5). Performance on the Nonsense Word Repetition Task was also correlated with the TERA ($p < .01$) but not with the TEWL, and there was no correlation between the Rapid Auditory Naming Task and either measure. Contrary with our hypothesis, none of the phonologic processing measures predicted the TERA or TEWL in regression models that adjusted for other significant predictors.

DISCUSSION

Among preschool-age children with moderate to severe speech-sound disorders (SSD), language skills, rather than speech (articulation) skills, were related to early reading and writing skills, as measured by the Test of Early Reading Ability-2 (TERA) and the Test of Early Written Language-2 (TEWL). Although children with comorbid language impairment (LI) had a more severe SSD on average than children with isolated SSD, articulation skills were not associated with early reading and writing skills in the final regression model. The severity of SSD therefore did not explain reading and writing outcomes. These results are consistent with prior studies of children at school age, which have found that language skills, rather than articulation skills, are related to reading abilities.[14,21,22]

Two key factors appear to contribute to the development of emergent literacy skills: phonologic processing and print concept knowledge. Although there has been significant research on the role of phonologic processing in the development of reading skills, particularly reading decoding,[7,56,57] the importance of print concept knowledge, a construct measured by the TERA and TEWL in the current study as an important explanatory variable for children's emerging literacy skills, is receiving attention as well.[17,58]

Children with isolated SSD in this sample appeared to have better print concept knowledge, whereas those with SSD and comorbid LI performed more poorly on these measures. Having SSD with comorbid LI was associated with poorer performance on measures of speech and language skills. In turn, two types of language-related skills, word knowledge and grammar skills, were positively associated with better performance on early reading and writing measures. This is consistent with a longitudinal study of somewhat older children with LI, in whom a grammar composite, nonverbal IQ, rapid naming, and phonologic awareness at kindergarten each contributed to the variance in reading abilities in the second and fourth grades.[12]

Articulation skills and narrative skills were not associated with early reading and writing outcomes in our study. There is concern, however, that children with SSD and comorbid LI may have a "double deficit," with a reciprocal negative effect of each condition on the other. We speculate that although both groups of children, those with and without comorbid LI, used language strategies to complete the early reading and writing measures, those without comorbid LI were able to use these strategies more effectively.

Early reading skills as measured by the TERA were correlated with performance on two of the three measures of phonologic processing, the latter measures being associated with reading decoding difficulties at school age.[7] Early writing skills as measured by the TEWL were correlated with only one of these measures. Children with early SSD are thought to be at risk for later reading decoding and spelling difficulties because poor phono-logic representations and phonologic memory limitations are hypothesized to underlie both SSD and reading disorders.[23,34,59-62] However, measures such as the TERA and TEWL do not directly assess word decoding or spelling abilities, skills that may not have yet emerged in pre-school-age children. Rather, these measures assess knowledge of the conventions of reading, including the ability to construct meaning from printed symbols, knowledge of the alphabet, and understanding of the conventions of written language (print concept knowledge).

Socioeconomic status (SES), as measured by the Hollingshead scale,[44] was associated with the development of early literacy skills, even in this sample with a relatively high mean SES. This is consistent with prior studies that find SES to be a significant predictor of both language and literacy skills.[7,28] Although male sex has been found to be associated with poorer language and reading skills in certain studies, this was not the case in our sample, except in the final model for the TEWL, in which male sex predicted poorer performance. There were more males than females in our sample, a finding consistent with other clinically referred samples.[4]

Few prior studies exist of early writing skills in preschool-age children with SSD. Our study demonstrated that these skills, measured by the TEWL, are impaired in children with LI to a similar degree as early reading skills as measured by the TERA. Furthermore, variables predicting performance on the TERA and on the TEWL were similar in our population.

In summary, assessment of print concept knowledge using the TERA and the TEWL in children with SSD, particularly those with comorbid LI, may identify children at biological risk for future reading disabilities. Knowledge of the conventions of print may well be necessary but is probably not sufficient for reading success in this population at high risk for reading disabilities.

Limitations

Limitations of the study include limited representation of families with lower SES in the sample. Because the population from which our sample was drawn was designed for a study of the genetics of SSD, families were recruited primarily from communities without a high rate

of poverty, which is associated with environmentally influenced (nongenetic) speech and language delays.[24,25]

The data available for the study are cross-sectional and thus do not indicate a causal relation between speech and language skills and reading/writing skills. Early academic achievement, as measured by the TERA or TEWL, may not be predictive of later academic achievement in this population. In prior studies, improvement in LI over time was found to predict improved reading scores, although children whose language scores improved remained at higher risk for reading difficulties than controls.[12,60] We plan on reassessing children at school age to determine whether SSD and LI at preschool age are developmental precursors of later reading disability.

Another study limitation was the absence of a control group of children without SSD. Such a group would have been useful in identifying potential weaknesses in the SSD only group, as well as the extent of deficits in the group with comorbid LI. Although unaffected siblings provided some comparison, because they were used to assess performance on nonstandardized measures, a genetic loading of SSD in the families of these children may have resulted in an underestimate of the degree of impairment in both groups, especially in view of the generally high SES levels of the study participants.

Last, the severity of SSD was greater in the group with comorbid LI than in the group without LI, so we are not able to determine the relative impact of LI and SSD in the group with both conditions. This could be addressed by including a comparison group with isolated LI, a rare finding in childhood, and thus provide a future direction for research.

Implications

The results of this study have potential implications for professionals providing services to children with LI. They indicate the potential value of assessing and incorporating instruction in preliteracy skills into treatment programs for preschool children with LI. The significant positive relationship between SES and preliteracy skills, within even this predominantly middle to upper middle class sample, provides further evidence that there can be value in enriching young children's literacy opportunities. In lower SES communities, the Reach Out and Read program, which provides books to young children and modeling of reading in primary care medical providers' offices, has been shown to improve a number of pre-academic outcomes and may potentially increase print concept knowledge and language skills.[63–65]

Last, many children with speech and language disorders may not be identified until school age. In a population-based study of children tested in kindergarten, Tomblin et al.[1] reported that among those determined to have a speech and language disorder, 29% had been previously identified, whereas 71% had not been identified. The severity of impairment was similar for children identified before school entry or during kindergarten. For pediatricians, the results of our study provide added incentive to screen young children for language delays because these children are at risk not only for language difficulties but may also be at a disadvantage in the development of preliteracy skills.

ACKNOWLEDGMENTS

This research was supported by grants K23 HD047713 from the National Institute of Child Health and Human Development (Laura Sices) and DC00528 from the National Institutes of Health, National Institute on Deafness and Other Communication Disorders, (Barbara A. Lewis). Thanks to Nori Minich for assistance with the factor analysis. Thanks to Stephanie Serna, MS, for assistance in formatting the manuscript.

REFERENCES

1. Tomblin JB, Records NL, Buckwalter P, Zhang X, Smith E, O'Brien M. Prevalence of specific language impairment in kindergarten children. J Speech Lang Hear Res 1997;40:1245–1260. [PubMed: 9430746]
2. Shriberg LD, Tomblin JB, McSweeny JL. Prevalence of speech delay in 6-year-old children and comorbidity with language impairment. J Speech Lang Hear Res 1999;42:1461–1481. [PubMed: 10599627]
3. Horwitz SM, Irwin JR, Briggs-Gowan MJ, Bosson Heenan JM, Mendoza J, Carter AS. Language delay in a community cohort of young children. J Am Acad Child Adolesc Psychiatry 2003;42:932–940. [PubMed: 12874495]
4. Shriberg LD. Five subtypes of developmental phonological disorders. Clin Commun Disord 1994;4:38–53. [PubMed: 8019550]
5. Wagner RK, Torgesen JK, Rashotte CA, et al. Changing relations between phonological processing abilities and word-level reading as children develop from beginning to skilled readers: a 5-year longitudinal study. Dev Psychol 1997;33:468–479. [PubMed: 9149925]
6. Gray A, McCutchen D. Young readers' use of phonological information: phonological awareness, memory, and comprehension. J Learn Disabil 2006;39:325–333. [PubMed: 16895157]
7. Lyon, GR.; Fletcher, JM.; Barnes, MC. Learning disabilities. In: Mash, EJ.; Barkley, RA., editors. Child Psychopathology. Vol. 2nd ed.. The Guilford Press; New York, NY: 2003. p. 520-585.
8. Lyytinen H, Ahonen T, Eklund K, et al. Early development of children at familial risk for dyslexia-follow-up from birth to school age. Dyslexia 2004;10:146–178. [PubMed: 15341196]
9. Schuele CM. The impact of developmental speech and language impairments on the acquisition of literacy skills. Ment Retard Dev Disabil Res Rev 2004;10:176–183. [PubMed: 15611989]
10. Kamhi AG, Catts HW. Toward an understanding of developmental language and reading disorders. J Speech Hear Disord 1986;51:337–347. [PubMed: 3773490]
11. Catts HW. The relationship between speech-language impairments and reading disabilities. J Speech Hear Res 1993;36:948–958. [PubMed: 8246483]
12. Catts HW, Fey ME, Tomblin JB, Zhang X. A longitudinal investigation of reading outcomes in children with language impairments. J Speech Lang Hear Res 2002;45:1142–1157. [PubMed: 12546484]
13. McArthur GM, Hogben JH, Edwards VT, Heath SM, Mengler ED. On the “specifics” of specific reading disability and specific language impairment. J Child Psychol Psychiatry 2000;41:869–874. [PubMed: 11079429]
14. Catts HW, Fey ME, Zhang X, Tomblin JB. Language basis of reading and reading disabilities: evidence from a longitudinal study. Sci Stud Reading 1999;48:1378–1396.
15. Catts HW, Adlof SM, Hogan TP, Weismer SE. Are specific language impairment and dyslexia distinct disorders? J Speech Lang Hear Res 2005;48:1378–1396. [PubMed: 16478378]
16. Gillam RB, Johnston JR. Development of print awareness in language-disordered preschoolers. J Speech Hear Res 1985;28:521–526. [PubMed: 4087887]
17. Justice LM, Bowles RP, Skibbe LE. Measuring preschool attainment of print-concept knowledge: a study of typical and at-risk 3- to 5-year-old children using item response theory. Lang Speech Hear Serv Sch 2006;37:224–235. [PubMed: 16837445]
18. Willinger U, Brunner E, Diendorfer-Radner G, Sams J, Sirsch U, Eisenwort B. Behaviour in children with language development disorders. Can J Psychiatry 2003;48:607–614. [PubMed: 14631881]
19. Irwin JR, Carter AS, Briggs-Gowan MJ. The social-emotional development of “late-talking” toddlers. J Am Acad Child Adolesc Psychiatry 2002;41:1324–1332. [PubMed: 12410075]
20. Raitano NA, Pennington BF, Tunick RA, Boada R, Shriberg LD. Pre-literacy skills of subgroups of children with speech sound disorders. J Child Psychol Psychiatry 2004;45:821–835. [PubMed: 15056313]
21. Lewis BA, Freebairn LA, Taylor HG. Follow-up of children with early expressive phonology disorders. J Learn Disabil 2000;33:433–444. [PubMed: 15495546]
22. Lewis BA, Freebairn LA, Taylor HG. Academic outcomes in children with histories of speech sound disorders. J Commun Disord 2000;33:11–30. [PubMed: 10665511]

23. Lewis BA, Freebairn L, Taylor GH. Correlates of spelling abilities in children with early speech sound disorders. Reading Writing Interdisciplinary J 2002;15:389–407.
24. Hart B, Risley TR. American parenting of language-learning children: persisting differences in family-child interactions observed in natural home environments. Dev Psychol 1992;28:1096–1105.
25. Hart, B.; Risley, TR. Meaningful Differences in the Everyday Experience of Young American Children. Paul H. Brookes; Baltimore, MD: 1995.
26. Nittrouer S. The relationship between speech perception and phonemic awareness: evidence from low-SES children and children with chronic OM. J Speech Hear Res 1996;39:1059–1070. [PubMed: 8898258]
27. Burgess SR. The influence of speech perception, oral language ability, the home literacy environment, and pre-reading knowledge on the growth of phonological sensitivity: a one-year longitudinal investigation. Reading Writing Interdisciplinary J 2002;15:709–737.
28. Burgess SR, Hecht SA, Lonigan CJ. Relations of the home literacy environment (HLE) to the development of reading-related abilities: a one-year longitudinal study. Reading Res Q 2002;37:408–426.
29. Burgess S. The role of shared reading in the development of phonological awareness: a longitudinal study of middle to upper class children. Early Child Dev Care 1997;127-128:191–199.
30. Neuman SB, Celano D. Access to print in low-income and middle-income communities: an ecological study of four neighborhoods. Reading Res Q 2001;36:8–26.
31. Storch SA, Whitehurst GJ. Oral language and code-related precursors to reading: evidence from a longitudinal structural model. Dev Psychol 2002;38:934–947. [PubMed: 12428705]
32. Scarborough, HS. Early identification of children at risk for reading disabilities: phonological awareness and some other promising predictors. In: Shapiro, BK.; Accardo, PJ.; Capute, AJ., editors. Specific Reading Disability: A View of the Spectrum. York Press; Timonium, MD: 1998. p. 75-119.
33. Catts HW, Fey ME, Zhang X, Tomblin JB. Estimating the risk of future reading difficulties in kindergarten children: a research-based model and its clinical implementation. Lang Speech Hear Serv Sch 2001;32:38–50.
34. Bird J, Bishop DV, Freeman NH. Phonological awareness and literacy development in children with expressive phonological impairments. J Speech Hear Res 1995;38:446–462. [PubMed: 7596110]
35. Catts HW, Gillispie M, Leonard LB, Kail RV, Miller CA. The role of speed of processing, rapid naming, and phonological awareness in reading achievement. J Learn Disabil 2002;35:509–524. [PubMed: 15493249]
36. Lewis BA, Freebairn L. Speech production skills of nuclear family members of children with phonology disorders. Lang Speech 1998;41:45–61. [PubMed: 9692321]
37. Lewis BA, Freebairn LA, Hansen AJ, et al. Dimensions of early speech sound disorders: A factor analytic study. J Commun Disord 2006;39:139–157. [PubMed: 16386753]
38. Goldman, R.; Fristoe, M. The Goldman-Fristoe Test of Articulation. American Guidance Service; Circle Pines, MN: 1986.
39. Khan, L.; Lewis, N. Khan-Lewis Phonological Analysis. American Guidance Service; Circle Pines, MN: 1986.
40. Robbins J, Klee T. Clinical assessment of oropharyngeal motor development in young children. J Speech Hear Disord 1987;52:271–277. [PubMed: 3455449]
41. Wechsler, D. Wechsler Preschool and Primary Scale of Intelligence-Revised. The Psychological Corporation; San Antonio, TX: 1989.
42. Reid, DK.; Hresko, WP.; Hammill, DD. Test of *Early Reading Ability (TERA-2)*. Vol. 2nd ed.. Pro-ed; Austin, TX: 1989.
43. Hresko, WP.; Herron, SR.; Peak, PK. Test of Early Written Language: A Method of Evaluating the Products and Processes of Emerging Writing Ability. Vol. 2nd ed.. Pro-ed; Austin, TX: 1996.
44. Hollingshead, AB. Four Factor Index of Social Class. Yale University; New Haven, CT: 1975.
45. Shriberg LD, Kwiatkowski J. Continuous speech sampling for phonologic analyses of speech-delayed children. J Speech Hear Disord 1985;50:323–334. [PubMed: 4057974]
46. Catts HW. Speech production/phonological deficits in reading disordered children. J Speech Hear Disabil 1986;19:504–508.

47. Newcomer, PL.; Hammill, DD. Test of Language Development-Primary. Vol. 2nd ed.. Pro-ed; Austin, TX: 1988.
48. Wiig, EH.; Secord, W.; Semel, E. Clinical Evaluation of Language Fundamentals-Preschool. Psychological Corp.; San Antonio, TX: 1992.
49. Shipley, KG.; Stone, TA.; Sue, MB. Test for Examining Expressive Morphology. Pro-ed; Austin, TX: 1983.
50. Dunn, L.; Dunn, L. Peabody Picture Vocabulary Test-Revised. American Guidance Service; Circle Pines, MN: 1981.
51. Gardner, MF. Expressive One-Word Picture Vocabulary Test (Revised). Academic Therapy Publications; Novato, CA: 1990.
52. Stein, NL.; Glenn, CG. An analysis of story comprehension in elementary school children. In: Freedle, RO., editor. New Directions in Discourse Processing. ABLEX Publishing Corp.; Norwood, NJ: 1979. p. 53-120.
53. Denkla MB, Rudel RG. Rapid “automatized” naming (RAN): Dyslexia differentiated from other learning disabilities. Neuropsychologia 1976;14:471–479. [PubMed: 995240]
54. Lewis BA, Freebairn L. Subgrouping children with familial phonologic disorders. J Commun Disord 1997;30:385–401. [PubMed: 9309530]
55. Winer, BJ. Statistical Principles in Experimental Design. Vol. 2nd ed.. McGraw Hill Book Company; New York, NY: 1971.
56. Pennington BF, Lefly DL. Early reading development in children at family risk for dyslexia. Child Dev 2001;72:816–833. [PubMed: 11405584]
57. Carroll JM, Snowling MJ, Hulme C, Stevenson J. The development of phonological awareness in preschool children. Dev Psychol 2003;39:913–923. [PubMed: 12952403]
58. Whitehurst GJ, Lonigan CJ. Child development and emergent literacy. Child Dev 1998;69:848–872. [PubMed: 9680688]
59. Lewis BA, Freebairn L. Residual effects of preschool phonology disorders in grade school, adolescence, and adulthood. J Speech Hear Res 1992;35:819–831. [PubMed: 1405539]
60. Bishop DV, Adams C. A prospective study of the relationship between specific language impairment, phonological disorders and reading retardation. J Child Psychol Psychiatry 1990;31:1027–1050. [PubMed: 2289942]
61. Webster PE, Plante AS, Couvillion LM. Phonologic impairment and prereading: update on a longitudinal study. J Learn Disabil 1997;30:365–375. [PubMed: 9220704]
62. Lewis BA, O'Donnell B, Freebairn L, Taylor GH. Spoken language and written expression: interplay of delays. Am J Speech Lang Pathol 1998;7:77–84.
63. Needlman R, Toker KH, Dreyer BP, Klass P, Mendelsohn AL. Effectiveness of a primary care intervention to support reading aloud: a multicenter evaluation. Ambul Pediatr 2005;5:209–215. [PubMed: 16026185]
64. Mendelsohn AL, Mogilner LN, Dreyer BP, et al. The impact of a clinic-based literacy intervention on language development in inner-city preschool children. Pediatrics 2001;107:130–134. [PubMed: 11134446]
65. Weitzman CC, Roy L, Walls T, Tomlin R. More evidence for reach out and read: a home-based study. Pediatrics 2004;113:1248–1253. [PubMed: 15121937]

Table 1

Demographic Characteristics of Study Participants (n = 125)

Variable	SSD Only (n = 59)	SSD and LI (n = 66)[a]
Child's characteristics		
Age (years), mean (SD)	5.3 (1.0)	5.1 (1.0)
Sex, n (%)		
Male	33 (56)	47 (71)
Female	26 (44)	19 (29)
Race, n (%)		
White	55 (93)	54 (80)
African American/Black	2 (3.5)	4 (6)
Other or more than 1 race	2 (3.5)	8 (12)
Family characteristic, n (%)		
Family's Hollingshead SES (n = 122)		
1 (lowest)	1 (2)	5 (8)
2	4 (7)	2 (3)
3	6 (10)	14 (22)
4	25 (43)	22 (34)
5 (highest)	22 (38)	21 (33)

[a]Chi-squared test used for categorical variables and independent sample *t*-test for continuous variables. *p* values for group differences greater than .05 (non-significant) for each. SSD, speech-sound disorder; LI, language impairment; SES, socioeconomic status.

Table 2

Factor Loadings of Early Childhood Speech and Language Measures in Four-Factor Solution

	Factor			
Measure (Variable Name)	**Articulation**	**Narrative**	**Grammar**	**Word Knowledge**
Speech error phrases	**0.821**		−0.205	
Multisyllabic words	**0.761**	0.101	0.165	
GFTA	**0.698**	−0.189	0.175	0.100
PCC-R	**0.594**		0.248	
Narrative: content items		**0.780**		
Narrative: factual questions	0.142	**0.541**		0.180
Narrative: inferential questions		**0.475**	0.107	
Grammatic completion[a]	−0.142		**0.795**	
Sentence imitation[a]	0.215		**0.668**	
Test of Early Expressive Morphology (TEEM)		0.143	**0.573**	0.189
Expressive vocabulary (EOWPVT-R)			0.139	**0.716**
Segmentation Task (phonologic awareness)				**0.619**
Receptive vocabulary (PPVT)		0.307	0.244	**0.448**

Bold values indicate highest loadings associated with each factor, n = 90.

[a]Grammatic completion and sentence imitation measures were based on comparable portions of Test of Language Development or Clinical Evaluation of Language Fundamentals-Preschool. GFTA, Goldman-Fristoe Test of Articulation; PCC-R, Percent of Consonants Correct-Revised; EOWPVT, Expressive One Word Picture Vocabulary Test; PPVT, Peabody Picture Vocabulary Test.

Table 3

Group Comparisons: Mean (SD) Scores[a] for Speech-Sound Disorder and Speech-Sound Disorder and Language Impairment Groups

Measures	SSD Only (n = 59)	SSD and LI (n = 66)	F Test for Group Differences[b]	Effect Size (Cohen's d)	*p* Value
Early literacy					
TERA (early reading readiness) (standard score)	103.2 (14.4)	94.1 (13.6)	9.45	0.65	<.01
TEWL (early writing skills) (standard score)	101.1 (10.2)	93.4 (8.7)	12.95	0.81	<.001
Factor composites					
Articulation (speech) (z score)	−1.11 (0.82)	−1.66 (0.87)	13.02	0.65	<.001
Narrative (speech and language) (z score)	−0.04 (0.80)	−0.87 (0.69)	32.11	1.11	<.001
Grammar (language) (z score)	−0.06 (1.00)	−1.63 (0.80)	83.48	1.73	<.001
Word knowledge (language) (z score)	0.53 (0.74)	−0.34 (0.92)	32.74	1.04	<.001
Intelligence testing					
Performance IQ (standard score)	105.7 (13.4)	95.8 (12.4)	11.96	0.77	.001
Phonologic processing					
Segmentation task (percent correct)[c]	68.3 (35.9)	50.9 (38.4)	5.31	0.47	<.05
Nonsense words (percent correct)	35.9 (26.9)	19.8 (24.2)	10.08	0.63	<.01
Rapid auditory naming (z score)[d]	−0.33 (1.01)	−0.25 (1.11)	0.15	0.07	NS

[a] Mean scores (SD) are presented unadjusted.

[b] F test and *p* value adjusted for differences in child's sex and socioeconomic status (SES) between groups. Adjusted statistics based on an n = 122 (instead of 125) because 3 subjects did not have SES data.

[c] 108 children completed the segmentation task (54 in each group).

[d] 115 children completed RANC (rapid auditory naming (colors)). SSD, speech-sound disorder; LI, language impairment; TERA, Test of Early Reading Ability; TEWL, Test of Early Written Language.

Table 4

Regression Models: Measures Associated with Early Reading/Writing Readiness

	Outcome: Test of Early Reading Ability (TERA)								
	Model 1			Model 2			Model 3 (Final)		
Measures	**β weights**	**R^2**	**F**	**β weights**	**R^2 Change**	**F**	**β weights**	**R^2 Change**	**F Test (*t*)**
SES	0.212*	.045***	5.637*	0.084	.256***	8.860***	0.056	.034*	8.566***
Factors									
Grammar				0.320**			0.254*		
Word knowledge				0.225*			0.198		
Articulation				0.053			0.037		
Narrative				0.009			0.011		
PIQ							0.209*		
	Outcome: Test of Early Written Language (TEWL)								
	Model 1			Model 2			Model 3 (Final)		
	β weights	**R^2**	**F**	**β weights**	**R^2 Change**	**F**	**β weights**	**R^2 change**	**F test (*t*)**
SES	0.291**	.115**	7.675**	0.149	0.295***	11.660***	0.109	.050**	12.138***
Sex	0.208**			0.192*			0.137		
Factors									
Grammar				0.368**			0.292**		
Word knowledge				0.267**			0.221*		
Articulation				−0.073			−0.084		
Narrative				0.047			0.053		
PIQ							0.261**		

SES, socioeconomic status; PIQ, performance IQ.

* $p < .05$;

** $p < .01$;

*** $p < .001$.

Table 5

Partial Correlation of Early Childhood Speech and Language Factors to Measures of Reading and Writing Readiness[a]

	Outcomes		Phonologic Processing			Factors				
Measures	**TERA**	**TEWL**	**Segmentation Task**	**Nonsense Words**	**Rapid Auditory Naming**	**Articulation**	**Narrative**	**Grammar**	**Word Knowledge**	**Performance IQ**
Outcomes										
Reading readiness (TERA)	1.000									
Writing readiness (TEWL)	0.513***	1.000								
Phonologic processing										
Segmentation task	0.283**	0.237*	1.000							
Nonsense words	0.320**	0.128	0.132	1.000						
Rapid auditory naming	0.198	0.080	0.097	0.025	1.000					
Factors										
Articulation	0.370***	0.202	0.180	0.755***	0.099	1.000				
Narrative	0.255*	0.299**	0.210*	−0.051	0.120	0.060	1.000			
Grammar	0.473***	0.494***	0.275**	0.482***	0.235*	0.501***	0.458***	1.000		
Word knowledge	0.426***	0.441***	0.785***	0.281**	0.163	0.359***	0.416***	0.565***	1.000	
Performance IQ	0.397***	0.457***	0.219*	0.134	0.028	0.270**	0.201*	0.462***	0.385‡	1.000

[a]Partial correlations adjusted for socioeconomic status and sex. Pearson correlations, two-tailed TERA, Test of Early Reading Ability; TEWL, Test of Early Written Language.

*$p < .05$;

**$p < .01$;

***$p < .001$